Computer programming

Just another programming weblog

2007-11-09

Minimum Spanning Trees: Prim's Algorithm

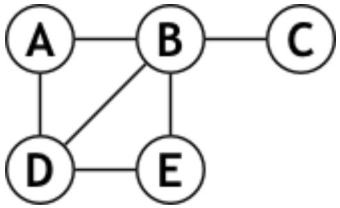
Posted by scvalex under Algorithms, Graphs | Tags: algorithm, C, graph, graph theory, minimal spanning trees, prim, prim's algorithm, programming, sourcecode, tree, tutorial |
[80] Comments
In this article I give an informal definition of a **graph** and of the **minimum spanning tree**. Afterwards I describe **Prim's algorithm** and then follow its execution on an example. Finally, the code in C is provided.

Graphs

Wikipedia gives one of the common definitions of a **graph**:

> *In computer science, a graph is a kind of data structure, specifically an abstract data type (ADT), that consists of a set of nodes and a set of edges that establish relationships (connections) between the nodes. The graph ADT follows directly from the graph concept from mathematics.*
> *Informally, G=(V,E) consists of vertices, the elements of V, which are connected by edges, the elements of E. Formally, a graph, G, is defined as an ordered pair, G=(V,E), where V is a finite set and E is a set consisting of two element subsets of V.*

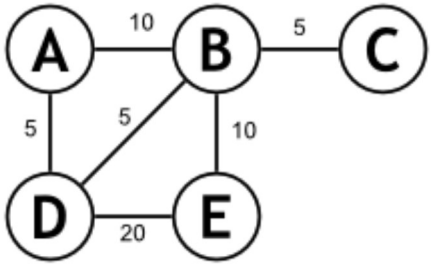
This is a **graph**:



It's a set of nodes (A, B, C, D and E) and the edges (lines) that interconnect them.

An important thing to note about this graph is that the edges are bidirectional, i.e. if A is connected to B, then B is connected to A. This makes it an undirected graph.

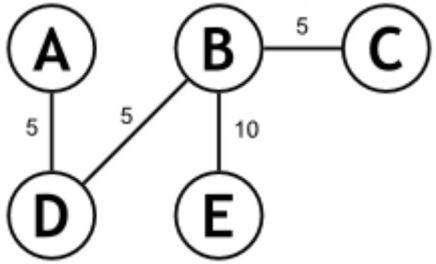
A common extension is to attribute **weights** to the edges. This is what I've done with the previous graph:



Minimum spanning trees

Basically a minimum spanning tree is a **subset of the edges of the graph**, so that **there's a path form any node to any other node** and that **the sum of the weights of the edges is minimum**.

Here's the minimum spanning tree of the example:



Look at the above image closely. It **contains all of the initial nodes** and some of the initial edges. Actually it contains **exactly *n – 1* edges**, where *n* is

the number of nodes. It's called a tree because there are no cycles.

You can think of the graph as a map, with the nodes being cities, the edges passable terrain, and the weights the distance between the cities.

It's worth mentioning that a graph can have several minimum spanning trees. Think of the above example, but replace all the weight with *1*. The resulting graph will have *6* minimum spanning trees.

Given a graph, find one of its minimum spanning trees.

Prim's Algorithm

One of the classic algorithms for this problem is that found by Robert C. Prim. It's a **greedy** style algorithm and it's guaranteed to produce a correct result.

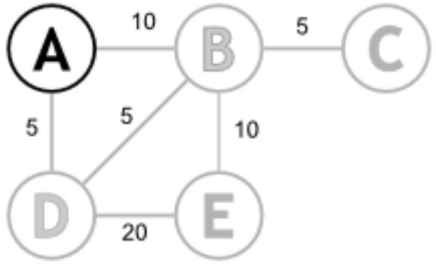
In the following discussion, let the distance from each node not in the tree to the tree be the edge of minimal weight between that node and some node in the tree. If there is no such edge, assume the distance is infinity (this shouldn't happen).

The algorithm (greedily) builds the minimal spanning tree by iteratively adding nodes into a working tree:

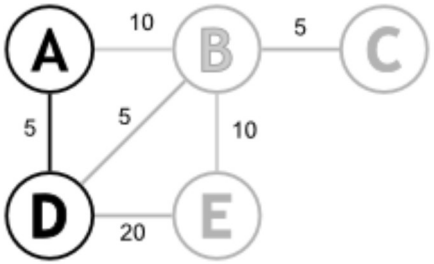
1. Start with a tree which contains only one node.
2. Identify a node (outside the tree) which is closest to the tree and add the minimum weight edge from that node to some node in the tree and incorporate the additional node as a part of the tree.
3. If there are less then $n - 1$ edges in the tree, go to **2**

For the example graph, here's how it would run:

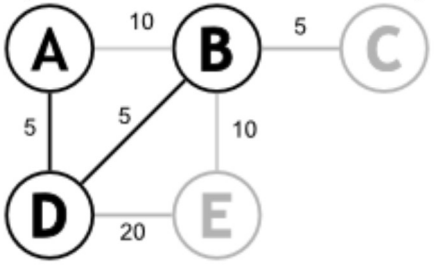
Start with only node A in the tree.

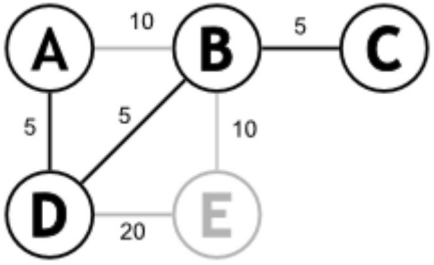


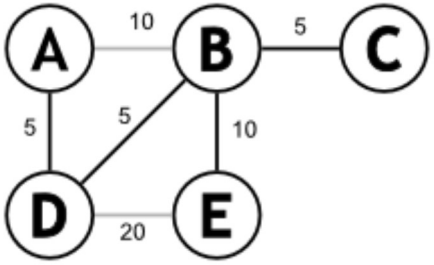
Find the closest node to the tree, and add it.



Repeat until there are *n – 1* edges in the tree.







The Programme

The following programme just follows the algorithm. It runs in $\mathbf{O(n^2)}$ time.

Here's the code in C (prim.c):

```c
#include <stdio.h>

/*
    The input file (weight.txt) look something like this
        4
        0 0 0 21
        0 0 8 17
        0 8 0 16
        21 17 16 0

    The first line contains n, the number of nodes.
    Next is an nxn matrix containg the distances between the nodes
    NOTE: The distance between a node and itself should be 0
*/

int n; /* The number of nodes in the graph */

int weight[100][100]; /* weight[i][j] is the distance between node i and node j;
            if there is no path between i and j, weight[i][j] should
            be 0 */

char inTree[100]; /* inTree[i] is 1 if the node i is already in the minimum
            spanning tree; 0 otherwise*/

int d[100]; /* d[i] is the distance between node i and the minimum spanning
        tree; this is initially infinity (100000); if i is already in
        the tree, then d[i] is undefined;
        this is just a temporary variable. It's not necessary but speeds
        up execution considerably (by a factor of n) */

int whoTo[100]; /* whoTo[i] holds the index of the node i would have to be
            linked to in order to get a distance of d[i] */

/* updateDistances(int target)
    should be called immediately after target is added to the tree;
    updates d so that the values are correct (goes through target's
    neighbours making sure that the distances between them and the tree
    are indeed minimum)
*/
void updateDistances(int target) {
```

```
41      int i;
42      for (i = 0; i < n; ++i)
43          if ((weight&#91;target&#93;&#91;i&#93; != 0) && (d&#91;i&#93; > weight[target][i])) {
44              d[i] = weight[target][i];
45              whoTo[i] = target;
46          }
47  }
48
49  int main(int argc, char *argv[]) {
50      FILE *f = fopen("dist.txt", "r");
51      fscanf(f, "%d", &n);
52      int i, j;
53      for (i = 0; i < n; ++i)
54          for (j = 0; j < n; ++j)
55              fscanf(f, "%d", &weight&#91;i&#93;&#91;j&#93;);
56      fclose(f);
57
58      /* Initialise d with infinity */
59      for (i = 0; i < n; ++i)
60          d&#91;i&#93; = 100000;
61
62      /* Mark all nodes as NOT beeing in the minimum spanning tree */
63      for (i = 0; i < n; ++i)
64          inTree&#91;i&#93; = 0;
65
66      /* Add the first node to the tree */
67      printf("Adding node %c\n", 0 + 'A');
68      inTree&#91;0&#93; = 1;
69      updateDistances(0);
70
71      int total = 0;
72      int treeSize;
73      for (treeSize = 1; treeSize < n; ++treeSize) {
74          /* Find the node with the smallest distance to the tree */
75          int min = -1;
76          for (i = 0; i < n; ++i)
77              if (!inTree&#91;i&#93;)
78                  if ((min == -1) || (d&#91;min&#93; > d[i]))
79                      min = i;
80
```

```
81              /* And add it */
82              printf("Adding edge %c-%c\n", whoTo[min] + 'A', min + 'A');
83              inTree[min] = 1;
84              total += d[min];
85
86              updateDistances(min);
87          }
88
89          printf("Total distance: %d\n", total);
90
91          return 0;
92      }
```

And here's a sample input file (dist.txt). It's the example graph:

```
5
0 10 0 5 0
10 0 5 5 10
0 5 0 0 0
5 5 0 0 20
0 10 0 20 0
```

The code's commented and there shouldn't be any problems.

Good luck. Always open to comments.

80 Responses to “Minimum Spanning Trees: Prim’s Algorithm”

1. Programming Tutorials Says:

   2007-12-05 at 21:19
   Programming Tutorials

   I couldn’t understand some parts of this article, but it sounds interesting

   Reply
2. safa Says:

   2008-03-05 at 19:17
   i try to execute the code but there is a mistake with the code
   also i couldnt understand this lines in the code
   {{{}}}
   int main(int argc, char *argv[]) {
   FILE *f = fopen(“dist.txt”, “r”);
   fscanf(f, “%d”, &n);
   int i, j;
   for (i = 0; i < n; ++i)
   for (j = 0; j < n; ++j)
   fscanf(f, “%d”, &weight[i][j]);
   fclose(f);

   Reply
   1. shubhika Says:

      2010-05-03 at 11:38
      you are donkey or stupit,you have nothing to do?

      Reply

1. sayem Says:

   2012-07-17 at 5:34
   You cann't say like that. It represents yourself. fool…….

3. wat's prim's algorithm? - Exforsys Says:

   2008-03-10 at 22:42
   […] this site Minimum Spanning Trees: Prim's Algorithm ◆ Computer programming _____ http://www.vbuniverse.com Blog for latest […]

   Reply
4. Rajendra Patel Says:

   2008-03-11 at 15:38
   Source is so helpful to me. Thank you…

   Reply
5. chetan sood Says:

   2008-04-15 at 22:38
   thank you thats very helpful, and its awe fully nice of you to make the effort to make it so easily understandable

   Reply
6. rooby Says:

   2008-05-24 at 22:35
   thanks alot it is very helpful

   Reply
7. Aya Raafat Says:

   2008-06-01 at 11:09
   Thanks very much, it's very helpful, the first time i fully understand the MST :).

   Reply
8. Tales Says:

2008-07-01 at 1:39
Thanks… The source is very clear and nice to read

Reply

9. nnb Says:

2008-07-15 at 19:34
I love You man. U saved me ^_^

Reply

10. orangeman Says:

2008-09-04 at 21:50
use "if (!inTree[i] && (weight[target][i] != 0) && (d[i] > weight[target][i]))" instead of "if ((weight[target][i] != 0) && (d[i] > weight[target][i]))" is better.

Reply

1. Chi Says:

2010-10-16 at 21:36
I can confirm this is an error. Please fix it.

Reply

11. Dan Says:

2008-11-11 at 4:42
Algorithm is nicely explained, very clear and lots of comments……

Reply

12. Manoj Says:

2008-11-17 at 18:42
thank u very much…if not full i understood something about this..

Reply

13. tony Says:

2008-11-22 at 8:25
"int main(int argc, char *argv[])"

It looks like you want to use command line to open the input file.

But, you assign the name of the input file here.

"FILE *f = fopen("dist.txt", "r")"

So, just use "int main()" should be clear.

Reply

14. zzzzz Says:

2008-12-11 at 6:26
i transfer this c to java code, there is problem with this code,
/* Find the node with the smallest distance to the tree */
int min = -1;
for (i = 0; i d[i]))
min = i;
this part need deep modification, other than that, this is good prim example to use. also WhoTo [], i still don't know if i need that or not. i from pt of view, i think that array can be ignore. one more comment, after u change that code, the value of total at the end is need modify if u want total to show up right.

as i said this code is very helpful, but i had spend over 10 hr to make it right into java.

Reply

1. rosemizie Says:

2009-06-10 at 17:22
for zzzz,

could u share with me a source code in java. i'm as a teacher want to share it with my students.):

Reply

2. Anum Says:

2015-10-09 at 0:19
Hi, could I please see your version of this in Java? As I would like to understand how to do this in Java. Also does it check if a cycle is created? Thank you. My email address is anum_n@hotmail.co.uk

Reply

15. rup Says:

2009-02-19 at 10:17
chup
vua codeeeeeeeeeeeeeeeeeeeeeeee
wrong code
disgusting code
it does not help me

Reply

16. rup Says:

2009-02-19 at 10:18
how much a code disgusting can be!!!!!!!!!
I cant imagine until I saw this code

Reply

17. Alex Says:

2009-05-09 at 23:09
Thank you so much for this awesome code!

Reply

18. Alex Says:

2009-05-09 at 23:09
And for the clear and well written explanations as well, of course! =)

Reply

1. rosemizie Says:

2009-06-10 at 17:26
dear alex,

hi, i'm everything new in this topic, could you send a source code in java or c++. which compiler we have to use better?):

Reply

1. rosemizie Says:

2009-06-10 at 17:27
dear alex,

my emel is rosemizie@hotmail.com

god bless you if you can help me.

19. rosemizie Says:

2009-06-10 at 17:19
does anybody hava a source code in java or c++.

Reply

1. rajesh Says:

2012-05-16 at 7:05
i have the java code please call me to this number +919032897206

Reply

20. SHREE Says:

2009-11-03 at 4:15
nice article.keep the good work up

Reply

21. jyo Says:

2009-11-19 at 13:25

hi ,

I have tried ' prims ' c code in linux . compilation is OK . but while i run the code ,it shows segmentation fault .

Please give th solution ? so that the program will run !!!

Reply

22. Anh Phúc Lê Says:

2009-12-01 at 12:15
i don't understand "int main(int argc, char *argv[])". please help me.
Thanks anyway!

good luck.

Reply

23. Rinku Says:

2010-03-18 at 10:01
can somebody explain how to use input file . i tried to run the program by copying the input file and typing the address of the file while input command but nothing happened. plz give explaination how to do it??

Reply

24. arch Says:

2010-03-23 at 16:14
this code is abs cool. thanks to the pgmr

Reply

25. Sanrik Says:

2010-03-27 at 12:12
this code is very clearly and simply written,and the way it has been explained is awesome

Reply

26. shijuschatz Says:

2010-04-26 at 8:23
algorithm explained neatly…well done good job…….

Reply

27. shahrazan Says:

2010-04-30 at 7:15
thanksssssssss

Reply

28. mina Says:

2010-06-06 at 17:18
hello. please email me a good article about prim algorithm or huffman algorithm.

Reply

29. ganesh Says:

2010-10-21 at 22:10
thanks for contents

Reply

30. Zacard Says:

2010-10-31 at 3:11
very good program, can anyone help me with parallel version of Prim's method (using OpenMP, Win32 or POSIX)?

Reply

31. Panayiotis Says:

2010-11-12 at 16:38
very nice but i want a code not to start from node A to every nodes but to read a txt file like B-E. B is the node i want to start and E the end node. Sorry for my English :)

Reply

32. Programmer Says:

2010-11-23 at 16:51
ata na jata ,chunav chinha chhata,,,
ab se sahi programme likhna you donkey

Reply

33. hoshyar Says:

2010-11-23 at 23:49
thanks alot for your code

Reply

34. Teddy Says:

2010-12-01 at 4:13
//You have to do corner case processing when min is -1

```
if(min != -1)
{
printf("Adding edge %c-%c\n", whoTo[min] + 'A', min + 'A');
inTree[min] = 1;
total += d[min];
updateDistances(min);
}
else
{
break;
}
```

Reply

35. Jane Says:

2010-12-18 at 6:35
this code cannot check whether the graph is connected or not

Reply

1. jose Says:

2010-12-29 at 11:03
donde debo colocar el archivo dist para q el programa lo lea????

Reply

36. sana Says:

2011-02-01 at 6:59
i cant understand this

Reply

37. vinodhini Says:

2011-03-26 at 8:51
i get a segmentation fault in this program

Reply

38. Fali Says:

2011-04-13 at 5:16
thanks, it helps me a lot :)

Reply

39. MPONGANO Radjab Says:

2011-04-18 at 13:19
Please I would like to know how spanning trees are alike

Reply

40. Rajul Says:

2011-07-29 at 6:40
Does this code check for cycles ..And avoid them..Can u tell me in which part of this code its being done..!!

Reply

41. parminder kaur rathore Says:

2011-08-27 at 6:43
very nice article….
u have solved my problem…
thankew…

Reply

42. Sapan Shah Says:

2011-09-18 at 7:43
Hey friends…
I m SAPAN.
Plz send me the prims sudeo code at sapan.shah177@gmail.com…
Plz fast because tomorrow exam… So plz send me…..

Reply

43. most current technology Says:

2011-09-20 at 9:44
latest technologies…

[…]Minimum Spanning Trees: Prim's Algorithm « Computer programming[…]…

Reply

44. dilip Says:

2011-09-22 at 10:01
hiiiiiiiiii

Reply

45. anonymous Says:

2011-10-06 at 14:36
DUDE, thank- you so very much man… it took me days but i finally cracked it :P
urs is probably the only perfectly working code for the algorithm…hats off dude…pls keep up the gr8..sry amazing work.

Reply

46. Imran Says:

2011-10-17 at 16:57
great work bro!!!!!

Reply

47. Roberto Says:

2011-10-20 at 22:56
you are amazing!!! i have been two days trying to solve and your code will save me today…. thanks a lot

Reply

48. socia'net for musicians Says:

2011-11-06 at 0:51
socia'net for musicians…

[…]Minimum Spanning Trees: Prim's Algorithm « Computer programming[…]…

Reply

49. alias548 Says:

2011-11-28 at 2:44
Thank you very much :) I appreciate loading from a file, amazing.

Reply

50. john Says:

2011-11-30 at 4:11
thank you very much for sharing this lesson^^

Reply

51. renu Says:

2011-12-01 at 10:53
cheers!!
tanx a lottt

Reply

52. lokesh pr. singh Says:

2011-12-02 at 5:27
thnx; its good enough…

Reply

53. Durga Devi Says:

2012-03-17 at 8:19
very clearly explained…

Reply

54. ADNAN MUKHTIAR AHMADANI Says:

2012-04-05 at 8:20
THIS IS SO COMPLICATED CODE,,, TRY TO SIMPLE IT ,,,,,

Reply

55. Peet Says:

2012-04-05 at 10:21
Does someone have this code in Matlab for me please? I need it for my Genetic Algorithm's initial population because I've been struggling now for a long time and no one can help me please?

Reply

56. Sarah Says:

2012-04-16 at 17:27
sir if we want to find a minimum spanning tree for specific points e.g for three points then how to code this problem

Reply

57. Sunny Says:

2012-04-17 at 22:41
java code for freckles kruskal's algorithm pleaseeeeee???

Reply

58. Nono Jiku Says:

2012-05-09 at 23:36
Brilliant.

Reply

59. TOVAR Says:

2012-07-04 at 7:50
thanks a lot! you saved my life!

We must to set the input file on the same place where the .cpp file is saved
Change your input text file in the code

Reply

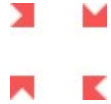
60. Basavaraj Says:

2012-07-10 at 10:06
very nice,,,,

Thanks to all

Reply

61. Hanoch Says:



2012-08-07 at 8:15
thnks

Reply

62. jangbahadur patel Says:

2012-09-04 at 17:41
jangbahaudr patel

it was a very nice stuff for me..

Reply

63. Neethu Says:

2012-10-06 at 8:10
gr8……..

Reply

64. Md Ali Hossain Says:

2012-11-16 at 14:00
core java code for distance between one vertex to another vertex in weighted graph

Reply

65. Curtis Bos Says:

2012-12-05 at 19:30
Thank you so much. This code is so much clearer than the code that is in my textbook. Meaningful variable names (rather than, 'x', 'y', 'D', 'i', 'j'. Seriously. The textbook doesn't declare a single variable as an actual word. They're all just letters), and good documentation go a long way. Thanks for your help.

Reply

66. rko Says:

2013-01-12 at 9:33
any one have c# code in MST using windows forms

Reply

67. InvisibleM Says:

2013-02-27 at 20:19
Thanks

Reply

68. babi Says:

2013-03-07 at 9:18

fuck you code

Reply

69. Efrain Says:

2013-07-05 at 20:38
Hurrah! At last I got a website from where I know how to in fact obtain valuable data concerning my study and knowledge.

Reply

70. http://Www.Useyourmind.info/ Says:

2013-08-23 at 18:52
Heya i am for the first time here. I came across this board and I find It really useful & it helped me out a lot. I hope to give something back and help others like you aided me.

Reply

71. Tilak Basnet Says:

2015-03-16 at 4:50
This is really very helpful for student

Reply